HETDEX: VIRUS Spectrographs Assembly and Alignment

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Abstract

We describe the mechanical assembly and optical alignment process used to construct the Visual Integral-Field Replicable Unit Spectrograph (VIRUS) instrument. VIRUS is a set of 150+ optical spectrographs designed to support observations for the Hobby-Eberly Telescope Dark Energy Experiment (HETDEX). To meet the accuracy, interchangeability, time and cost constraints, a production line will be set up to construct and test modular subassemblies in parallel. To facilitate the VIRUS production, fixtures and adjustment apparatuses have been designed to aid in assembly and alignment. This poster describes the details and operations of the camera mirror, collimator mirror and grating adjustment apparatuses used to in the VIRUS spectrographs.

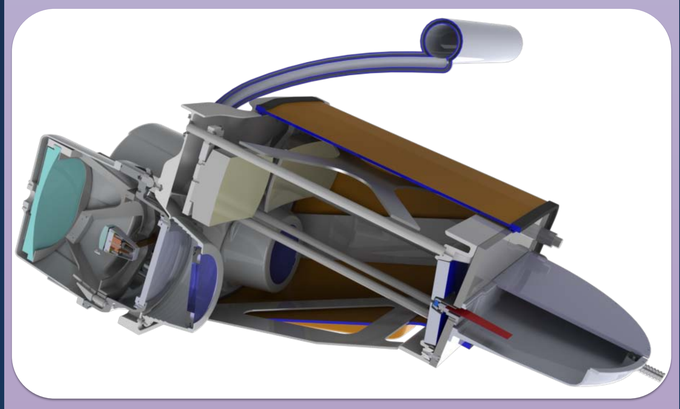
Introduction

Visual Integral-Field Replicable Unit Spectrograph (VIRUS) is an instrument that will support observations Hobby-Eberly Telescope Dark Energy Experiment (HETDEX) Project. HETDEX will use VIRUS with the upgraded Hobby-Eberly telescope (HET) to probe for Dark Energy at high redshifts. VIRUS is comprised of 150 to 192 optical spectrographs, for which Texas A&M University is responsible for much of the manufacturing, assembly, and testing.

This poster describes conceptual and prototyped designs of the adjustment apparatuses that will be used to accurately and repeatably align the optics in the VIRUS instrument. These adjustment apparatuses are used on the spectrographs after they have been assembled to do the final optical alignment. Having these adjustments allows the components to have looser tolerances, which will decrease the cost of the instrument and number of scrapped parts. A fiducial camera and collimator is used to align the collimator mirror and camera mirror, respectively. This allows each camera and collimator to be virtually interchangeable. The grating will be adjusted to each collimator-camera pair.

Instrument Overview

The VIRUS instrument consists of between 150 and 192 simple fiber fed optical spectrographs. The unit spectrographs are assembled in pairs, and consist of a simple Schmidt spectrograph (referred to as the "collimator") with an on-axis Schmidt vacuum camera. A volume phase holographic (VPH) grating provides a wavelength range of 350-550 nm. The detailed optical and mechanical designs of the instrument are described in more detail elsewhere at this conference. The VIRUS unit spectrographs will be mounted on the sides of the telescope structure; each spectrograph is fiber-fed from the focal plane of the HET. The following figure shows a drawing of a pair of VIRUS unit spectrographs.



Section-view drawing of a pair of VIRUS spectrographs.

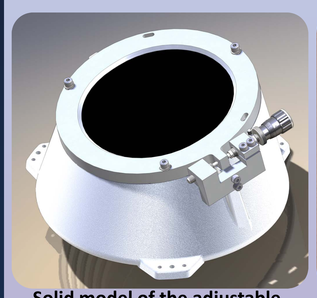
Grating

Design Requirements

It is necessary for the clocking of the grating substrate to be aligned within 0.1° of the center plane of the CCD. Due to mechanical tolerance stack up within the collimator and camera, the grating must be aligned after a collimator is paired with a camera. After adjustments are complete the grating's alignment should be locked. However, it must also have the ability to later be adjusted, in case the collimator is later paired with another camera.

Design Solution

To facilitate the need of adjusting the grating after the collimator and camera have been paired, the grating will be glued to a cell, which can rotate on a housing unit. The grating will be glued into its cell with RTV, and a mark from the manufacturer will be used to roughly align the grating in its cell. Two pins fixed to the housing unit will slide in arced slots in the grating cell, causing the cell to follow a circular path. A micrometer and spring plunger will temporarily fasten to the housing unit and push & pull on the cell's tab to rotate the cell. To align the grating, a fiber bundle is attached to the collimator-camera pair and the micrometer is adjusted until the image on the camera's CCD shows the light is properly aligned the CCD's pixels. Once aligned, three clamping screws are tightened to lock the rotation, and three dabs of epoxy are applied to the edge between the cell and housing. If the grating ever needs to be readjusted, the epoxy dabs can be broke off and the screws loosened.



Solid model of the adjustable grating system.

Working prototype of the adjustable grating cell.

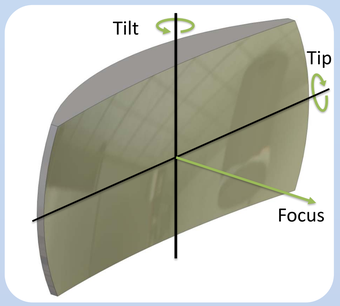
Collimator Mirror

Design Requirements

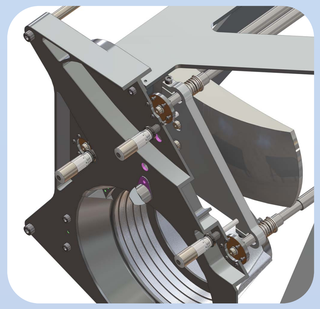
Once the collimator mirror has been installed, its tip, tilt and focus need be adjusted. All the other degrees of freedom will be fixed. In order for the mirror to be accurately aligned, the resolution of the adjustors must be relatively high. Also, once the adjustments are complete the mirror's alignment must be locked.

Design Solutions

To adjust the tip, tilt and focus a three point adjustment system will be used. Three 10 micron resolution micrometers will be threaded into the chassis and push against the collimator mirror mounting plate. There are also three springs that push back against the micrometers. To align the mirror, a fiducial camera and fiber bundle will be set up, and the three micrometers will be adjusted until the light on the fiber is positioned and focused on the camera's CCD within acceptable limits. Once the mirror is aligned, three clamps will be tightened along the mounting rods to fix the mirror in place, and the micrometers are removed to be used on the next spectrograph.



Collimator mirror with adjustable degrees of freedom.



Section-view showing the collimator mirror, mounting plate and micrometers.

Camera Mirror

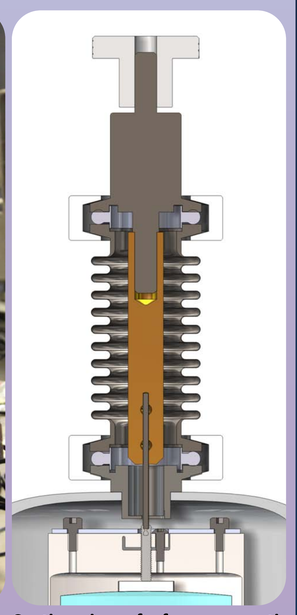
Design Requirements

It is necessary to adjust the camera mirror's tip, tilt, and focus. The adjustments must be done in vacuum and with the detector cooled. Once the adjustment is complete the alignment must be locked.

Design Solutions

To adjust the tip, tilt and focus a three point adjustment system will also be used. Three set screws will push against the camera mirror and the opposing spring plungers. Since the adjustments must be done under vacuum, a specialized cover was made for the camera, called the adjustor back. The adjustor back uses ferro-magnetic feedthroughs, bellows and hex keys to tighten and loosen the set screws under vacuum. To align the mirror, a fiducial collimator and fiber bundle will be set up, and the three set screws will be adjusted with the adjustor back until the light on the fiber is positioned and focused on the camera's CCD within the acceptable limits. Once the mirror has been aligned, three clamps will be tightened to fix the mirror in place. These clamps are tightened with the same hex keys that adjust the set screws.

Working prototype of the adjustor back with all the operational components.



Section view of a ferro-magnetic feedthrough, bellow and hex key tightening a set screw.

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Illuminating the Darkness

HETDEX

Hobby-Eberly Telescope Dark Energy Experiment